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I, the undersigned, hereby declare that the annexed document is an accurate English translation of the below-identified document, that the translation was duly made by me, and that I am fully familiar with both English and Japanese, for which I will assume any responsibility:

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[Title of the Invention] TELECOMMUNICATION TERMINAL APPARATUS

[Claims for the Patent]

[Claim 1]

A telecommunication terminal apparatus capable of giving a notification sound using a melody, characterized by comprising:

storage means capable of storing musical composition data;

point register means for storing information indicative of an arbitrary performance starting position of the musical composition data; and

musical tone-generating means responsive to an instruction for starting the notification sound, for reading out the musical composition data from said storage means and for reproducing the readout musical composition according to the information indicative of the performance starting position, stored in said point register means, thereby generating the melody starting from the arbitrary position of the musical composition data.

[Claim 2]

A telecommunication terminal apparatus according to claim 1, characterized in that said musical tone-generating means is responsive to an instruction for ending the notification sound, for stopping reproducing the musical composition data and for writing information indicative of a reproduction ending position of the reproduced musical composition data into said point register means.

[Claim 3]

A telecommunication terminal apparatus according to claim 2, characterized in that a plurality of starting points suitable for starting performance are set in the

musical composition data, and in response to the instruction for ending the notification sound, a closest starting point posterior to the information indicative of the reproduction ending position of the reproduced musical composition data is written into said point register means.

[Claim 4]

A telecommunication terminal apparatus according to claim 1, characterized in that a plurality of starting points suitable for starting performance are set in the musical composition data, and in response to the instruction for starting the notification sound, the musical composition data is read out and reproduced from a closest starting point posterior to the information indicative of the performance starting position stored in said point register means.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a telecommunication terminal apparatus which is capable of giving a notification sound using a melody, and more particularly to a telecommunication terminal apparatus which can be suitably applied to a car telephone and a cellular phone.

[0002]

[Conventional Art]

In a mobile telecommunication system such as a PDC (Personal Digital Cellular telecommunication system), known as an analog cellular system or a digital cellular system, and a Personal Handy-phone System (PHS), when a cellular phone carried by the user receives an incoming call, an alert sound is generated to notify the user of the incoming call. As the alert sound, a beep has been conventionally used, but recently, a melody has come to be used in place of the beep since the beep is offensive

to the ear.

[0003]

[Problems to be Solved by the Invention]

A conventional cellular phone, which is capable of reproducing a melody, is equipped with a musical tone-reproducing means that is capable of playing automatic performance. The musical tone-reproducing means generally comprises a Central Processing Unit (CPU), a ROM (Read Only Memory), a RAM (Random Access Memory), and a musical tone-reproducing section, and is adapted to read out musical composition data stored in the ROM or the RAM, and to set tone generation parameters to the musical tone-reproducing section so as to generate the musical composition by the execution of an automatic performance program, by the CPU, stored in the ROM.

To produce high-quality musical tones, the recent musical tone-reproducing means are equipped with a plurality of sounding channels, and adapted to be able to reproduce a musical composition composed of a plurality of parts.

[0004]

However, in the conventional telecommunication terminal apparatus such as a cellular phone, a melody for notifying the user of an incoming call or a call-hold is set to be reproduced from the leading end of a musical composition designated in advance, and hence it is difficult to listen to the entire musical composition.

The present invention is therefore aimed at providing a telecommunication terminal apparatus which is capable of giving a notification using a melody, and allowing a musical composition to be listened from an arbitrary position thereof.

[0005]

[Means for Solving the Problems]

To attain the above object, a telecommunication

terminal apparatus according to the present invention capable of giving a notification sound using a melody, comprises storage means that is capable of storing musical composition data, point register means for storing information indicative of an arbitrary performance starting position of the musical composition data, and musical tone-generating means for reading out the musical composition data from the storage means and reproduces the musical composition according to the information indicative of the performance starting position, stored in the point register means, in response to an instruction for starting the notification sound, to thereby generate the melody starting from the arbitrary position of the musical composition data.

[0006]

In the aforementioned telecommunication terminal apparatus according to the present invention, in response to an instruction for ending the notification sound, the musical tone-generating means may stop reproducing the musical composition data and write information indicative of a reproduction ending position of the reproduced musical composition data into the point register means.

Further, in the aforementioned telecommunication terminal apparatus according to the present invention, a plurality of starting points suitable for starting performance are set in the musical composition data, and in response to the instruction for ending the notification sound, a closest starting point posterior to the information indicative of the reproduction ending position of the reproduced musical composition data may be written into the point register means.

Still further, in the aforementioned telecommunication terminal apparatus according to the present invention, a plurality of starting points suitable for starting performance are set in the musical

composition data, and in response to the instruction for starting the notification sound, the musical composition data may be read out and reproduced from a closest starting point posterior to the information indicative of the performance starting position stored in the point register means.

[0007]

According to the present invention constructed above, the point register means for storing information indicative of an arbitrary performance starting position of musical composition data is provided, so that in response to an instruction for starting a notification sound, the musical composition data is read out and reproduced according to the information indicative of the performance starting position stored in the point register means. Therefore, it is possible to reproduce and listen to musical composition data from an arbitrary position thereof.

Further, when an instruction for ending a notification sound, information indicative of a reproduction ending position of the reproduced musical composition data is written into the point register means, so that the musical composition data can be reproduced and listened to from a position where reproduction has been previously ended. Further, a plurality of starting points suitable for starting performance are set in advance in musical composition data, and in response to an instruction for ending a notification sound, a starting point closest to a notification sound ending position is written into the point register means, so that the musical composition data can be reproduced from a position suitable for starting performance. In this case, when an instruction for starting a notification sound is given, musical composition data may be reproduced from a starting point closest to a position

stored in the point register means.

[0008]

[Embodiments of the Invention]

FIG. 1 is an example of the arrangement of an embodiment in the case where a telecommunication terminal apparatus according to the present invention is applied to a cellular phone.

A cellular phone 1 in FIG. 1 includes an antenna 1a, which is usually configured to be retractable and connected to a communication section 13 having a modulating/demodulating function. A CPU (Central Processing Unit)10 for a system is a system controller that controls the operations of component parts of the cellular phone 1 by executing telephone function programs, and includes a timer for indicating a time period elapsed during operation thereof and generating a timer interrupt at predetermined time intervals. Further, the system CPU 10 carries out a musical composition reproduction-related process, described later. A system RAM 11 is a RAM (Random Access Memory) which is provided with a musical composition data storage area for storing data of musical compositions each composed of a plurality of parts downloaded from a download center or the like, a user setting data storage area, a work area for the system CPU 10, and so forth. A system ROM 12 is a ROM (Read Only Memory) which stores various telephone function programs for transmissions and receptions and other programs for carrying out the musical composition reproduction-related process, and other programs, which are executed by the system CPU 10, and various data such as preset musical composition data.

[0009]

The communication section 13 carries out demodulation of a signal received by the antenna 1a, and modulation of a signal to be transmitted to supply the

modulated signal to the antenna 1a. A received speech signal demodulated by the communication section 13 is decoded by an audio processing section (coder/decoder) 14, while a sending speech signal input via a microphone 21 is compression-encoded by the audio processing section 14. The audio processing section 14 carries out compression-encode/decode of speech with high efficiency, and is implemented by a coder/decoder based on a CELP (Code Excited LPC) method or an ADPCM (Adaptive Differential PCM) method. A musical tone-generating section 15 causes the received speech signal from the audio processing section 14 to be sounded via a received speech speaker 22, or reproduces musical composition data to generate and output an incoming call melody and a hold sound. It should be noted that the incoming call melody is sounded via an incoming call speaker 23, while the hold sound is mixed with a received speech signal and sounded via the received speech speaker 22.

[0010]

The musical composition data is comprised of tone color data, tempo data, and note data composed of a plurality of parts. The musical tone-generating section 15 is adapted to reproduce musical tones based on the musical composition data, and has a FIFO memory incorporated therein, for storing the note data during the reproduction of the musical composition data. The FIFO memory may have such a storage capacity as to store note data of one musical composition, but it may be configured such that if the FIFO memory has a storage capacity which is too small to store note data of one musical composition, the musical tone-generating section 15 sends an interrupt request (IRQ) signal to the system CPU 10 when a predetermined amount of a free area occurs in the FIFO memory, and the system CPU 10 reads out a continued portion of the note data stored in the system

RAM 11 or the system ROM 12 and transfers the same to the musical tone-generating section 15.

[0011]

An interface (I/F) 16 is an interface for downloading musical composition data including one or more pieces of sequence data from an external device 20 such as a personal computer. An input section 17 is an input means comprised of dial buttons for inputting "0" to "9", respectively, and other buttons, which are provided in the cellular phone 1. A display 18 is a display for displaying a menu of telephone functions, and denotations in accordance with operations of respective buttons including the dial buttons. A vibrator 19 is a vibrator which vibrates the body of the cellular phone 1 upon receipt of an incoming call instead of an alert sound to thereby notify the user of the incoming call. It should be noted that the functional blocks send and receive data and instructions to and from each other via a bus 24.

[0012]

FIG. 2 shows a first configuration of the musical tone-generating section 15 of the cellular phone 1 according to the embodiment of the present invention. According to the first configuration, the musical tone-generating section 15 is adapted to have a sequence function. Before describing the first configuration, the data structure of musical composition data which is reproduced by the musical tone-generating section 15 will be described by referring to FIG. 3.

The musical composition data in FIG. 3 indicates musical composition data stored in the system RAM 11 or the system ROM 12. As shown in FIG. 3, the musical composition data is formed of a header located at the leading end, and tone color data, tempo data, note data, and end data for each part, which are arranged in this

order. The note data is formed of note data of respective parts sequentially arranged; as shown in FIG. 3, note data is comprised of part data indicative of the part to which it belongs, scale data comprised of note information and octave information, interval data indicative of a time length between the present note data and the next note data, and sounding tone length data comprised of tone length information indicative of a quarter note, an eighth note, or the like. It should be noted that a pause (rest) is represented by the interval data.

[0013]

The resolution of the interval data and the tone length data in the note data depends on the tempo data; if the tempo data varies, the period of time actually indicated also varies even if the value of the interval data or the value of the tone length data remains unchanged. Further, a plurality of marks are inserted into the musical composition data such that they are located at positions suitable for starting performance. These marks may be set such that they are located at the leading end of an introduction pattern, a main pattern, a fill-in pattern, an ending pattern, and the like.

[0014]

Further, by detecting the end data which is disposed at the trailing end of the musical composition data, it can be detected that the musical composition data has been completed. Therefore, if there is musical composition data to be reproduced next, preparations can be made for reproducing the same.

Further, the musical composition data is comprised of a plurality of parts, e.g. four parts: a melody part, an accompaniment part 1, an accompaniment part 2, and a rhythm part. The musical composition data can be downloaded from a distribution center or the like via e.g.

a base station 2 appearing in FIG. 1. The downloaded musical composition data is stored in the system RAM 11. It should be noted that the base station 2 is provided with an antenna 2a for a base station.

[0015]

The cellular phone 1 according to the embodiment of the present invention is adapted to be able to reproduce musical composition data having the data structure shown in FIG. 3 from an arbitrary position thereof. In this case, a starting position of the musical composition data is adapted such that reproduction starts from a performance starting position of the musical composition data, which is indicated by performance starting position information stored in a performance starting point register 36.

As shown in FIG. 2, the musical tone-generating section 15 is comprised of an interface (I/F) 30, a FIFO (First-In First-Out) 31, a sequencer 32, a tone generator 33, a digital-to-analog converter (DAC) 34, and an OR circuit 35.

The interface 30 is connected to the system CPU 10 via the bus 24, so that musical composition data read out from the system RAM 11 or the system ROM 12 under the control of the system CPU 10 is written into a data register therein via the bus 24. In this case, the system CPU 10 reads out tone color data and tempo data in the musical composition data, and transfers the readout data to the interface 30. The CPU system 10 then reads out performance starting position information from the performance starting point register 36 of the musical tone-generating section 15 so that the musical composition data can be read out from a position corresponding to the performance starting position information. The system CPU 10 then transfers note data from a position indicated by the readout performance

starting position information to the interface 30.
[0016]

The note data (Data) from the position indicated by the performance starting position information of the musical composition data written in the data register of the interface 30 is written into the FIFO 31, and the tone color data of each part of the musical composition data written in the data register is transferred to the tone generator 33.

Registers incorporated in the interface 30 include a sequencer control register, the data register, and a status register. The sequencer control register is a register into which sequencer control data for controlling the sequencer 32 is written by the system CPU 10. The sequencer control data written into the sequencer control register includes sequencer start instruction data (Start) which indicates an instruction to start reproducing musical tones, and a sequencer stop instruction data which indicates an instruction to stop reproducing musical tones.
[0017]

The data register is a register into which musical composition data is temporarily written by the system CPU 10. In the musical composition data written in the data register, note data from a performance starting position is written into the FIFO 31, tone color data is written into the tone generator 33, and tempo data (Temp) is transferred to the sequencer 32.

The status register is a register which indicates a musical tone-generating status of the musical tone-generating section 15. The status register includes a note data empty flag (Empty) output from the FIFO 31 and a musical composition data end flag (END) output from the sequencer 32. The status register is a register from which readout is performed by the system CPU 10.

[0018]

The FIFO 31 has a capacity of 32 bytes (32 x 8 bits), for example, into which note data from a performance starting position of the selected musical composition data is sequentially written via the data register of the interface 30 by the system CPU 10, and from which in response to a readout request signal (Req) from the sequencer 32, the note data are sequentially read out in an order in which they were written. The note data read out by the sequencer 32 is discarded from the FIFO 31. In addition to this FIFO function, the FIFO 31 has a function of monitoring the amount of note data stored therein, and a function of generating a note data empty signal (Empty) to set the note data empty flag in the status register of the interface 30 when the amount of note data becomes equal to or less than a certain amount of data (for example, 8 bytes) predetermined by the system CPU. It should be noted that the note data empty signal is delivered as an interrupt request (IRQ) signal to the system CPU 10 via the OR circuit 35.

[0019]

When sequencer start instruction data is written into the sequencer control register in the interface 30 by the system CPU 10, a sequencer start instruction (Start) is issued for an operation as outlined below. Before the sequencer start instruction, however, tempo data (Temp) needs to be transferred to the sequencer 32, tone color data of each part needs to be written into the tone generator 33, and a certain amount of note data from a performance starting position needs to be written into the FIFO 31.

[0020]

The sequencer 32, first, captures note data at the leading end stored in the FIFO 31. The note data at the leading end is usually comprised only of interval data

for sounding a first musical tone. After waiting for timing in which a waiting time based on the interval data and the tempo data has elapsed, the sequencer 32 captures the next note data, and generates sounding parameters such as a key-on, a key-off, and a key code based on scale data and sounding tone length data of the captured note data, and supplies the sounding parameters to the tone generator 33. The sequencer 32 then captures the following note data in the above timing, and prepares for the next reproduction. The preparation for the next reproduction means time management according to the captured noted data, and the time management is performed according to tempo data and interval data. According to the supplied sounding parameters, the tone generator 33 generates musical tones of each part specified by the sounding parameters. In this case, the tone color of the musical tones generated in the part is assumed to be the tone color of the part set by the tone color data supplied in advance from the interface 30.

[0021]

Then, after waiting for timing in which a period of time corresponding to the sounding tone length data included in the note data has elapsed, the tone generator 33 is allowed to stop reproducing. The same generating process is then carried out for note data captured next. The generating process is carried out until the user gives an instruction for ending reproduction. When the instruction for ending reproduction is detected, the sequencer 32 and the tone generator 33 stop operation, and the data in the FIFO 31 is entirely cleared. Further, the sequencer 32 generates a musical composition data end signal (END), and writes positional information indicative of the end of reproduction as performance starting position information into the performance starting point register 36 via the interface 30 so that a

continued portion of the musical composition data can be reproduced next time. It is preferred that the performance starting point information written into the performance starting point register 36 should be designated as a starting point which is the position of a mark detected first after the position of the musical composition data where reproduction thereof has been actually ended. It should be noted that the instruction for ending reproduction is given when an incoming call button of the input section 17 is operated, a call-hold operation is canceled, or the communication line is cut off in the cellular phone 1.

[0022]

The tone generator 33 generates PCM waveform data composed of a plurality of parts based on the sounding parameters such as a key-on, a key-off, and a key code, and outputs the same. The digital-to-analog converter 34 converts the PCM waveform data into an analog musical tone signal. In the case where the musical tone signal is used as a melody for notifying the user of an incoming call, the generated melody is sounded via the incoming call speaker 23. Also, in the case where the musical tone signal is used as a melody for notifying the user of a call-hold, the reproduced melody (a sending hold sound) is supplied to the audio processing section 14, and is compression-encoded with high efficiency and transmitted to the caller.

[0023]

The OR circuit 35 transmits an interrupt request (IRQ) signal to the system CPU 10 in accordance with a note data empty signal (Empty) which is output from the FIFO 31 when the amount of note data stored in the FIFO 31 becomes equal to or smaller than a predetermined amount of data. The OR circuit 35 also generates an interrupt request (IRQ) signal to the system CPU 10 in

accordance with a musical data end flag (END) output from the sequencer 32. In response to the interrupt request (IRQ) signal, the system CPU 10 examines the cause of the interrupt request (IRQ) signal by making reference to the flag in the status register of the interface 30 to thereby perform suitable processing. On this occasion, when determining that the note data empty flag is set and hence the interrupt request (IRQ) signal is caused by a shortage in the amount of note data in the FIFO 31, the system CPU 10 transfers note data of 32 bytes - 8 bytes = 24 bytes, for example. In the note data transfer, the following note data is read out and transferred from the system RAM 11 or the system ROM 12. The note data of 24 bytes should not necessarily be transferred immediately, and all the note data of 24 bytes should not necessarily be transferred. It suffices that the note data is transferred in such timing and amount that the musical tone-generating section 15 reproduces musical tones without interruption.

Further, if the musical data end flag is set in the status register of the interface 30, the musical composition data is read out again from the leading end thereof and transferred to the interface 30, or if a musical composition to be reproduced next has been designated, musical composition data thereof is read out from the system RAM 11 or the system ROM 12 and transferred to the interface 30.

[0024]

As described above, in the musical tone-generating section 15 appearing in FIG. 2, when the system CPU 10 gives an instruction for starting reproduction of a melody, the sequencer 32 detects this instruction to start generating the melody. It should be noted that the instruction for starting reproducing a melody by the system CPU 10 is given when reproduction of an alert

sound (an incoming call melody) is started upon receipt of an incoming call by the cellular phone 1 and when reproduction of a hold sound is started by operating the call-hold key of the cellular phone 1.

Therefore, in the cellular phone 1, a melody notifying the user of an incoming call can be reproduced and listened to from an arbitrary position of musical composition data set by the user. In this case, by operating various buttons, the user may write an arbitrary performance starting position into the performance starting point register 36 storing performance starting point information on musical composition data. Since it is preferred that the performance starting position should be a starting point indicated by a mark inserted into musical composition data, it may be configured such that each time the user operates a button, the performance starting position written into the performance starting point register 36 can be incremented/decremented to a starting point indicated by the next mark.

[0025]

FIG. 4 shows a second configuration of a musical-tone generating section of the cellular phone 1 according to the embodiment of the present invention shown in FIG. 1. In a musical tone-generating section 115 constructed according to the second configuration, the system CPU 10 is adapted to execute the sequence function. The data structure of musical composition data to be reproduced by the musical tone-generating section 115 constructed according to the second configuration is the same as the data structure described above with reference to FIG. 3.

The musical tone-generating section 115 constructed according to the second configuration as shown in FIG. 4 is also configured to start reproducing for listening musical composition data from an arbitrary position

thereof.

[0026]

As shown in FIG. 4, the musical tone-generating section 115 is comprised of an interface (I/F) 130, a tone generator 133, and a digital-to-analog converter (DAC) 134.

The interface 130 is connected to the system CPU 10 via the bus 24, so that sounding parameters generated by the system CPU 10 as well as tone color data in musical composition data read out from the system RAM 11 or the system ROM 12 are written into a data register therein via the bus 24. The sounding parameters are generated by an execution of a sequence processing program by the system CPU 10 based on the readout note data from a performance starting position of the musical composition data stored in the system RAM 11 or the system ROM 12.

[0027]

The interface 130 supplies the written sounding parameters as well as the tone color data to the tone generator 133. According to the supplied sounding parameters, the tone generator 133 generates musical tones of a part specified by the sounding parameters. In this case, the tone color of the musical tones generated for the part is assumed to be the tone color of the part set by the tone color data supplied from the interface 130. The tone generator 133 generates and outputs PCM waveform data composed of a plurality of parts since the sounding parameters such as a key-on, a key-off, and a key code are sequentially supplied. The PCM waveform data is converted by the digital-to-analog converter (ADC) 134 into an analog musical tone signal. In the case where the musical tone signal is used as a melody for notifying the user of an incoming call, the generated melody is sounded via the incoming call speaker 34. On the other hand, in the case where the musical tone signal

is used as a melody for notifying the user of a call-hold, the reproduced melody (sending hold sound) is supplied to the audio processing section 14, and is compression-encoded with high efficiency and transmitted to the caller.

[0028]

A description will now be given of a musical composition reproducing process including a sequence process carried out by the system CPU 10 which supplies sounding parameters to the musical tone-generating section 115 constructed according to the second configuration as described above.

When the receipt of an incoming call is detected and when the call-hold key is operated and a call-hold is detected in the cellular phone 1, the system CPU 10 starts generating a melody. First, the system CPU 10 reads out musical composition data for use in generating a melody from the system RAM 11 or the system ROM 12. In this case, first, the system CPU 10 reads out tone color data and tempo data in the musical composition data. Then, the system CPU 10 reads out performance starting position information from the region of a performance starting point register reserved in the system RAM 11, and reads out musical composition data from a position corresponding to the performance staring position information.

[0029]

Tone color data of each part of the readout musical composition data is written into the interface 130. The system CPU 10 interprets note data from the performance starting position in the readout musical composition data. Note that data at the leading end of the note data is comprised only of interval data for sounding a first musical tone. Then, after waiting for timing in which a waiting time based on the interval data and the tempo

data read out from the system RAM 11 or the system ROM 12 has elapsed, the system CPU 10 reads out the next note data, and generates sounding parameters such as a key-on, a key-off, and a key code based on scale data and sounding tone length data of the readout note data and writes the same into the interface 130. Then, the system CPU 10 reads out the following note data to prepare for the next reproduction. The preparation for the next reproduction means time management according to the following note data, and the time management is performed according to tempo data and interval data. The interface 130 supplies the sounding parameters written therein to the tone generator 133, and in accordance with the supplied sounding parameters, the tone generator 133 generates musical tones of a part specified by the sounding parameters. In this case, the tone color of musical tones generated in the part is assumed to be the tone color of the part set by the tone color data supplied in advance from the interface 130.

[0030]

Then, after waiting for timing in which a period of time corresponding to the sounding tone length data included in the note data has elapsed, the system CPU 10 causes the tone generator 133 to stop reproducing musical tones. The system CPU 10 then carries out the above described musical tone-reproducing process for note data read out next. The system CPU 10 carries out the musical tone-generating process until the user gives an instruction for ending reproduction. When the instruction for ending reproduction is detected, the system CPU 10 stops the sequence operation and causes the musical tone-generating section 115 to stop operation. Further, a musical composition data end signal (END) is generated, the system CPU 10 writes positional information indicative of the end of reproduction as

performance starting position information into the performance starting point register of the RAM 12 so that a continued portion of the musical composition data can be reproduced next time. It is preferred that the performance starting point information written into the performance starting point register should be designated as a starting point which is the position of a mark detected first after the position of the musical composition data where reproduction thereof has been actually ended. It should be noted that the instruction for ending reproduction is given when an incoming call button of the input section 17 is operated, a call-hold operation is canceled, or the communication line is cut off in the cellular phone 1.

[0031]

FIG. 5 shows a flow chart of a musical composition-reproducing main process 1 carried out by the system CPU 10 in the telecommunication terminal apparatus according to the present invention. Here, the musical composition-reproducing main process 1 will be described by making reference to the configuration of the musical tone-generating section 15 shown in FIG. 2.

When the musical composition-reproducing main process 1 is started, determination is made in a step S10 whether a musical composition-reproducing trigger has been detected or not. In this case, when the receipt of an incoming call is detected and when the call-hold key is operated to hold a call in the cellular phone 1, it is determined that there is a musical composition-reproducing trigger. Here, if it is determined that there is the receipt of a incoming call or a call-hold, and there is thus the musical composition-reproducing trigger, tone color data and tempo data in musical composition data of the selected musical composition number are read out from the system RAM 11 or the system

ROM 12 and transferred to the musical tone-generating section 15 in a step S11. Then, a performance starting position information is read out from the performance starting point register 36 in a step S12. In a step S13, note data of musical composition data is read out from the position corresponding to the readout performance starting position, and transferred to the musical tone-generating section 15 until the FIFO 31 becomes full. The system CPU 10 detects the extent to which the musical composition data has been transferred, and stores an address of the leading end of musical composition data which should be transferred next.

[0032]

Then, in a step S14, the system CPU 10 transfers a reproduction start command (Start) to the musical tone-generating section 15. As a result, the musical tone-generating section 15 reproduces musical tones based on the transferred tone color data, tempo data, and note data to start generating a melody. In this case, the musical tone-generating section 15 reproduces and sounds a melody from a performance starting position stored in the performance starting point register 36.

The musical tone-generating section 15 reproduces a musical composition until a musical composition ending trigger is detected in a step S15. This musical composition ending trigger is detected when the incoming call button of the input section 17 is operated or the call-hold operation is canceled in the cellular phone 1. Also, the musical composition ending trigger is detected when the communication line is cut off.

[0033]

When the musical composition ending trigger is detected, reproduction stop command (Stop) is transferred to the musical composition-generating section 15 to cause the operation of the musical tone-generating section 15

to stop and to be cleared in a step S16. Then, in a step S17, a performance ending position is detected as the trailing end of the musical composition data having been reproduced when the musical tone-generating section 15 is caused to stop operation. In a step S18, the detected performance ending position is compared with a starting point of the musical composition data, into which a mark is inserted. If they coincide with each other, the starting point is detected, and if they do not coincide with each other, the closest starting point after the performance ending position is detected. Then, in a step S19, the detected starting point is written as performance starting position information into the performance starting point register to terminate the musical tone-reproducing main process 1. On the other hand, if the musical composition reproducing trigger is not detected in the step S10, the musical composition-reproducing main process 1 is directly terminated.

[0034]

In the above described musical composition-reproducing main process 1, the musical tone-generating section 15 reproduces and sounds musical composition data from a performance starting position stored in the performance starting point register 36. Thus, a starting point coincident with a performance ending position or the closest starting point after the performance ending position is stored as performance starting position information in the performance starting point register 36, and hence when the musical composition-reproducing main process 1 is started next time, the musical composition data can be reproduced for listening from a position where reproduction was ended or from a position suitable for starting performance after the position where reproduction was ended.

[0035]

FIG. 6 shows a flow chart of a second musical composition-reproducing main process 2 carried out by the system CPU 10 in the telecommunication terminal apparatus according to the present invention. In the musical composition-reproducing main process 2, a performance ending position is directly stored in the performance starting register 36. Here, the musical composition-reproducing main process 2 will be described by making reference to the configuration of the musical tone-generating section 15 shown in FIG. 2.

When the musical composition-reproducing main process 1 is started, determination is made in a step S20 whether a musical composition-reproducing trigger has been detected or not. In this case, when the receipt of an incoming call is detected and when the call-hold key is operated to hold a call in the cellular phone 1, it is determined that there is a musical composition-reproducing trigger. Here, if it is determined that there is the receipt of an incoming call or a call-hold, and there is thus the musical composition-reproducing trigger, tone color data and tempo data in musical composition data of the selected musical composition number are read out from the system RAM 11 or the system ROM 12 and transferred to the musical tone-generating section 15 in a step S21. Then, a performance starting position information is read out from the performance starting point register 36 in a step S22. In a step S23, the detected performance starting position information is compared with a starting point of the musical composition data, into which a mark is inserted. When they coincide with each other, the starting point is detected, and when they do not coincide with each other, the closest starting point after the performance ending position is detected. In a step S24, note data of musical composition data is read out from the position of the

detected starting point, and transferred to the musical tone-generating section 15 until the FIFO 31 becomes full. The system CPU 10 detects the extent to which the musical composition data has been transferred, and stores an address of the leading end of musical composition data which should be transferred next.

[0036]

Then, in a step S25, the system CPU 10 transfers a reproduction start command (Start) to the musical tone-generating section 15. As a result, the musical tone-generating section 15 reproduces musical tones based on the transferred tone color data, tempo data, and note data to start generating a melody. In this case, the musical tone-generating section 15 reproduces and sounds a melody from a starting point coincident with a performance starting position stored in the performance starting point register 36, or from the closest starting point after the performance starting position when the starting point does not coincide with the performance starting position.

The musical tone-generating section 15 reproduces a musical composition until a musical composition ending trigger is detected in a step S26. This musical composition ending trigger is detected when the incoming call button of the input section 17 is operated or the call-hold operation is canceled in the cellular phone 1. The musical composition ending trigger is also detected when the communication line is cut off.

[0037]

When the musical composition ending trigger is detected, reproduction stop command data (Stop) is transferred to the musical composition-generating section 15, to cause the operation of the musical tone-generating section 15 to stop and to be cleared in a step S26. Next, in a step S28, a performance ending position is detected

as the trailing end of the musical composition data having been reproduced when the musical tone-generating section 15 is caused to stop operation. Then, in a step S29, the detected starting position is written as performance starting position information into the performance starting point register 36 to terminate the musical tone-reproducing main process 2. On the other hand, if the musical composition reproducing trigger is not detected in the step S20, the musical composition-reproducing main process 2 is directly terminated.

[0038]

In the above described musical composition-reproducing main process 2, the musical tone-generating section 15 reproduces and sounds musical composition data from a starting point coincident with a performance starting position information stored in the performance starting point register 36, or from the closest starting point after the performance starting position information. Then, a performance ending position is stored as performance starting position information in the performance starting point register 36, and hence when the musical composition-reproducing main process 2 is started next time, the musical composition data can be reproduced for listening from the position where reproduction was ended or from a position suitable for starting performance after the position where reproduction was ended.

It should be noted that the telecommunication terminal apparatus according to the present invention is adapted to carry out either one of the musical composition-reproducing main process 1 and the musical composition-reproducing main process 2.

[0039]

By the way, the musical tone-generating section 15 may send an interrupt request (IRQ) signal to the system

CPU 10 while reproducing musical composition data. FIG. 7 shows a flow chart of an interrupt request process (IRQ process) carried out on this occasion. It should be noted that the interrupt request process is carried out between the steps S14 and S15 of the musical composition-reproducing main process 1 or between the steps S25 and S26 of the musical composition-reproducing main process 2.

When detecting the interrupt request signal (IRQ), the system CPU 10 starts interrupt request process and determines in a step S30 whether the interrupt request signal (IRQ) results from a note data empty signal (Empty) or not by making reference to the note data empty flag in the status register in the interface 30 of the musical tone-generating section 15. Since the note data empty flag, when set, indicates that there is a shortage in the amount of note data in the FIFO 31, the following note data is transferred to the musical tone-generating section 15 in a step S35, and the interrupt request process is terminated.

[0040]

On the other hand, if the note data empty flag is not set but the musical composition data end flag is set in the status register in the interface 30, the determination is made to be negative (NO) in the step S30, and the process then proceeds to a step S31. In other words, if the reproduction of musical composition data has been ended, the process proceeds to the step S31, and, in the step S31, it is then determined whether musical composition data to be reproduced next has been set or not. Here, if musical composition data to be reproduced next has been set, the process proceeds to a step S32 wherein tone color data and tempo data in the musical composition data to be reproduced next are read out from the system RAM 11 or the system ROM 12 and transferred to the musical tone-generating section 15. Then, in a step

S34, note data in the musical composition data is transferred from the leading end thereof to the musical tone-generating section 15 until the FIFO 31 becomes full. On the other hand, if it is determined in the step S31 that musical composition data to be reproduced next has not been set, the process branches to a step S33 wherein a return is made to the leading end of the musical composition data of which reproduction has been ended. Then, in a step S34, note data in the musical composition data is transferred from the leading end thereof to the musical tone-generating section 15 until the FIFO 31 becomes full. The system CPU 10 detects the extent to which the musical composition data has been transferred, stores an address of the leading end of musical composition data which should be transferred next to terminate the interrupt requiring process.

[0041]

It should be noted that when the cellular phone 1 is reset, the performance starting position information stored in the performance starting point register is initialized. Also, when a musical composition of an incoming call melody is changed, the performance starting position information stored in the performance starting point register is initialized.

As described above, the musical composition reproduction-related process and the telephone function process in the telecommunication terminal apparatus of the present invention are carried out by the system CPU 10 executing programs. The programs are preset in the system ROM 12, but may be installed into the system RAM 11 from the external device 20. If the programs are installed from the external device 20 as above, the programs can be easily replaced and version-updated. In this case, the external device 20 may be a drive for a removal disk such as a CD-ROM, an MO, or an HDD.

[0042]

Further, the above described tone generator 33 (133) of the musical tone-generating section 15 (115) may be configured by a tone generator based on a frequency-modulation method, i.e. an FM tone generator. The FM tone generator uses higher harmonics generated by frequency modulation to synthesize musical tones, and is capable of generating a waveform having higher harmonics components containing non-harmonic tones by a relatively simple circuit. The FM tone generator is capable of generating musical tones over a wide range from synthesized tones of natural musical instruments to electronic tones.

Further, although note data in musical composition data is transferred to the musical tone-generating section 15 until the FIFO 31 becomes full, alternatively, the note data may be transferred to the musical tone-generating section 15 until a predetermined amount of note data is stored in the FIFO 31.

The FM tone generator uses oscillators called operators that oscillate sinwaves equivalently, and can be formed by cascading a first operator and a second operator. Alternatively, the FM tone generator may be formed by feeding an operator's own output back to itself and inputting it.

[0043]

Further, the tone generator method used in the tone generator 33 (133) of the musical tone-generating section 15 (115) should not limited to the FM tone generator method, but may be another method such as a waveform memory tone generator (PCM tone generator or ADPCM tone generator) method or physical model tone generator method, and may be implemented by either a hardware tone generator using a DSP or the like or a software tone generator realized by execution of a tone generator

program.

It should be noted that the telecommunication terminal apparatus according to the present invention is by no means applied to only a cellular phone as described above, but may be applied to information apparatuses, personal computers, and so forth, which include musical tone-generating means.

[0044]

[Effects of the Invention]

As described above, in the present invention, point register means for storing information indicative of an arbitrary performance starting position of musical composition data is provided, so that in response to an instruction for starting a notification sound, the musical composition data is read out and reproduced according to the information indicative of the performance starting position stored in the point register means. Therefore, it is possible to reproduce and listen to musical composition data from an arbitrary position thereof.

Further, when an instruction for ending a notification sound, information indicative of a reproduction ending position of the reproduced musical composition data is written into the point register means, so that the musical composition data can be reproduced and listened to from a position where reproduction was previously ended. Further, a plurality of starting points suitable for starting performance are set in advance in musical composition data, and in response to an instruction for ending a notification sound, a starting point closest to the notification sound ending position is written into the point register means, so that the musical composition data can be reproduced from a position suitable for starting performance. In this case, when an instruction for starting a notification

sound is given, musical composition data may be reproduced from a starting point closest to a position stored in the point register means.

[Brief Description of the Drawings]

[FIG. 1]

FIG. 1 is an example of the arrangement of an embodiment in the case where a telecommunication terminal apparatus according to the present invention is applied to a cellular phone.

[FIG. 2]

FIG. 2 is a diagram showing a first configuration of a musical tone-generating section of the cellular phone according to the embodiment of the present invention.

[FIG. 3]

FIG. 3 is a diagram showing the data structure of musical composition data which is reproduced by the musical tone-generating section of the cellular phone according to the embodiment of the present invention.

[FIG. 4]

FIG. 4 is a diagram showing a second configuration of the musical tone-generating section of the cellular phone according to the embodiment of the present invention.

[FIG. 5]

FIG. 5 is a flow chart showing a musical composition-reproducing main process 1 in the case where the cellular phone according to the embodiment of the present invention is set as the musical tone-generating section of the first configuration.

[FIG. 6]

FIG. 6 is a flow chart showing a musical composition-reproducing main process 2 in the case where the cellular phone according to the embodiment of the present invention is set as the musical tone-generating section of the first configuration.

[FIG. 7]

FIG. 7 is a flow chart showing an interrupt request process (IRQ process) in the case where the cellular phone according to the embodiment of the present invention is set as the musical tone-generating section of the first configuration.

[Description of Reference Numerals]

1 cellular phone, 1a antenna, 2 base station, 2a base station antenna, 10 system CPU, 11 system RAM, 12 system ROM, 13 communication section, 14 audio processing section, 15 musical tone-generating section, 16 I/F, 17 input section, 18 display, 19 vibrator, 20 external device, 21 microphone, 22 received speech speaker, 23 incoming call speaker, 24 bus, 30 interface, 31 FIFO, 32 sequencer, 33 tone generator, 34 DAC, 35 OR circuit, 36 performance starting point register, 115 musical tone-generating section, 130 interface, 133 tone generator, 134 DAC